REMARKS

A Petition and fee for a Two-Month Extension of Time is filed concurrently herewith.

Claims 1-37 are all the claims presently pending in the Application. Claims 32-37 have been withdrawn from consideration. Claim 1 has been amended to more particularly define the invention. Attached hereto is a marked-up version of the changes made to the claims by the current Amendment.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 9, 11, 13, 16, 18 and stand rejected under 35 U.S.C. § 112, second paragraph as being indefinite. Claims 1-8, 26, 28 and 30 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Morita et al. (U.S. Patent No. 6,121,636). Claims 6, 12, 14, 15, 19 and 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Morita. Claims 4, 6, 10, 12, 14, 15, 17 and 19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Morita in view of Steigerwald (U.K. Patent App. 2,333,899A). Claims 2, 3, 5, 7, 9, 11, 13, 16, 18, 20-23, 25, 27, 29 and 31 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over either Morita or alternatively the combination of Morita and Steigerwald, and further in view of Lester (U. S. Patent No. 6,291,893).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention (e.g., as recited in claim 1) is directed to a light-emitting semiconductor device which includes a substrate, a plurality of semiconductor layers which comprise group III nitride group compound semiconductors and are laminated on the substrate by crystal growth, an emission layer formed on a first side of the substrate, and a mirror surface formed on a second side of the substrate opposite the first side.

Importantly, as defined by claim 1, the mirror surface may include a light transmission

layer which directly contacts the substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics, and a reflection layer which is formed on the light transmission layer, comprises a metal, and reflects lights emitted from the emission layer.

Alternatively (e.g., as recited in claim 2), the mirror surface may include a reflection layer which includes a metal and reflects lights emitted from the emission layer; and a corrosion-resisting layer which is formed on the reflection layer and includes at least one of a metal oxide and a ceramic.

Conventional light-emitting semiconductor devices include aluminum mirror surfaces formed on the reverse side of a substrate. However, after the mirror surface is formed, it is impossible to form a scribe line in the reverse side of the substrate. In addition, the metal layer deteriorates quickly causing a reduction in reflectivity of the mirror surface.

The claimed invention, on the other hand, may include a mirror surface which includes a light transmission layer, and a reflection layer which is formed on the light transmission layer, (e.g., as recited in claim 1) or a reflection layer, and a corrosion-resisting layer which is formed on the reflection layer (e.g., as recited in claim 2). These features help to provide a light-emitting device which has a larger luminous output and a longer performance life, and can be mass-produced at a low cost.

II. THE 35 USC §112, SECOND PARAGRAPH REJECTION

The Examiner alleges that claims 9, 11, 13, 16, 18 and 20 are indefinite for failing to particularly point out and distinctly claim the subject matter regarded as the invention. Applicant submits, however, that these claims are not indefinite.

Specifically, Applicant notes that claims 5, 7 and 9 have been amended to recite *"a light transmission layer"*.

In view of the foregoing, the Examiner is respectfully requested to withdraw this rejection.

III. THE PRIOR ART REFERENCES

A. The Morita Reference

The Examiner alleges that Morita teaches the claimed invention (e.g., claims 1-8, 26, 28 and 30) and suggests the claimed invention (e.g., claims 6, 12, 14, 15, 19 and 24). Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by Morita.

Morita discloses a semiconductor light emitting device which includes GaN semiconductor layers stacked on a front surface of a sapphire substrate, and a reflective film formed on a rear surface (Morita at Abstract).

However, Applicant submits that Morita does not teach or suggest a light-emitting semiconductor device having a mirror surface which includes "*a light transmission layer which directly contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics; and a reflection layer which is formed on said light transmission layer, comprises a metal, and reflects lights emitted from said emission layer*" as recited in claim 1, nor a mirror surface which includes "*a reflection layer which comprises a metal and reflects lights emitted from said emission layer; and a corrosion-resisting layer which is formed on said reflection layer and comprises at least one of a metal oxide and a ceramic*" as recited in claim 2.

As noted above, unlike conventional devices which have aluminum mirror surfaces formed on a reverse side of the substrate, the claimed device may include a mirror surface having a light transmission layer, and a reflection layer which is formed on the light transmission layer (Application at page 27, line 10-page 29, line 27; Figure 8) or a reflection layer, and a corrosion-resisting layer which is formed on the reflection layer (Application at page 32, line 24-page 33, line 17; Figure 11). These features help to provide a light-emitting device which has a larger luminous output an a longer performance life, and can be mass-produced at a low cost (Application at page 12, line 14-page 13, line 10).

Clearly, Morita does not teach or suggest these novel features. Indeed, Morita does not even recognize at least one of the problems (e.g., processing difficulties) which the

claimed invention was intended to address.

Indeed, Morita forms a metal reflection film made of Au etc. directly on the back surface of a substrate 1. On the contrary, in the present invention, a light transmitting layer made of a metal oxide film or a ceramic may be directly adjacent to the back surface of the substrate. Morita never teaches or suggests forming a light transmitting layer (as in the claimed invention) between the substrate and the metal reflection film.

By forming the light transmission layer (as in the claimed invention) first, impurities can be prevented from mixing when a reflection film is formed. Morita does not teach or suggest such a structure.

Further, the Examiner attempts to rely on col. 2, line 22 of Morita to support his position. However, this passage merely discloses that a reflective film may be a "multi-layered film of metals" (Morita at col. 2, lines 19-22). The Examiner also attempts to rely on col. 5, lines 14 and 18-23. However, referring to Figure 3, these passages merely disclose a reflective film 11 (e.g,. Au) which is deposited on the substrate 1, and a "light transmissive smoothing film of SiO2, SiN or glass" formed on the substrate 1, and the reflective film 11 formed on the smoothing film (Morita at col. 5, lines 14-24).

However, nowhere do these passages disclose the novel features of the claimed invention. Specifically, Applicant submits that the "smoothing film" of Morita cannot be equated with the "light transmission layer" of the claimed invention. Indeed, the "smoothing film" may be merely intended to smooth the surface of the substrate. Thus, the smoothing film may be formed in only the cracks or valleys of the substrate surface. In other words, the "smoothing film" is not necessarily formed on the entire substrate surface (Morita at col. 5, lines 17-22).

This is completely unrelated to the claimed "light transmission layer" of the claimed invention. Indeed, the light transmission layer of the claimed invention may be used to control gases volatilized from an adhesive sheet (Application at page 12, lines 14-18). More specifically, the light transmission layer may be in a range of 5 nm to 10 μm thick and include metal oxides and oxides having luminous transparency such as Al_2O_3, TiO_2, MgO, $MgCO_3$, Ta_2O_5, ZnO, In_2O_3, SiO_2, SnO_2, and ZrO_2 (Application at page 13, line 25-page 14, line 3).

Thus, the "smoothing film" of Morita cannot reasonably be equated with the "light transmission layer" of the claimed invention.

Likewise, Morita does not disclose a "corrosion-resisting layer" which may be formed on the reflection layer as recited, for example, in claim 2. Indeed, the Examiner even concedes that Morita does not disclose this feature of the claimed invention.

That is, with respect to claims 2 and 3, Morita directly forms a metal reflection film made of, e.g., Au, on the back surface of the substrate 1. The metal reflection layer is adhered to a lead frame 21 by an adhesive 22. On the contrary, in the present invention, a corrosion-resistant layer may be adhered to a lead frame by an adhesive. Accordingly, the metal reflection layer is not necessarily adjacent to the adhesive directly in the present invention.

Further, as recited in claim 3, a light transmitting layer, a reflection layer, and a corrosion-resistant layer may be formed on the substrate in sequence, and the corrosion resistant layer may be adhered to the lead frame by using the adhesive.

By forming the light transmission layer first, impurities can be prevented from mixing when a reflection film is formed, and because the reflection layer is not adherent to the adhesive directly, the reflection layer (e.g., made of metal) is not corroded. Such a structure is clearly not taught or suggested by Morita.

Therefore, it is clear that Morita does not teach or suggest the novel features of the claimed invention. Thus, the Morita device would likely experience the same problems encountered with conventional devices (e.g., after the mirror surface is formed, it would be impossible to form a scribe line in the reverse side of the substrate, and the reflection layer would deteriorate quickly causing a reduction in reflectivity of the mirror surface) as described in the Background section of the Application.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Morita. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Steigerwald Reference

Regarding the §103 rejection, the Examiner alleges that Steigerwald would have been

combined with Morita to form the claimed invention (e.g., as claimed in claims 4, 6, 10, 12, 14, 15, 17 and 19). Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Steigerwald discloses a light-emitting diode (LED) in which an opaque material 14 is placed between the LED die 16 and the die attach epoxy 20. The opaque material 14 may be used to improve thermal resistance or light output of the LED (Steigerwald at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems. Specifically, Morita is intended to prevent a deterioration in luminance, whereas Steigerwald is intended to improve the reliability of LED packages. Clearly, no person of ordinary skill in the art would have considered combining these references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner merely states that it would have been obvious to combine these references "because Steigerwald teaches that these metals are more highly reflective of certain III-N wavelengths and for the purpose of reducing manufacturing costs". This assertion, without more, is insufficient to support the combination.

Moreover, Applicant submits that Steigerwald does not teach or suggest a light-emitting semiconductor device having a mirror surface which includes "*a light transmission layer which directly contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics; and a reflection layer which is formed on said light transmission layer, comprises a metal, and reflects lights emitted from said emission layer*" as recited in claim 1, nor a mirror surface which includes "*a reflection layer which comprises a metal and reflects lights emitted from said emission layer; and a corrosion-resisting layer which is formed on said reflection layer and comprises at least one of a metal oxide and a ceramic*", as recited in claim 2.

As noted above, the claimed invention includes novel features (e.g., a novel mirror surface) which help to provide a light-emitting device which has a larger luminous output an

a longer performance life, and can be mass-produced at a low cost (Application at page 12, line 14-page 13, line 10).

Clearly, Steigerwald does not teach or suggest these novel features. Indeed, Steigerwald does not even recognize at least one of the problems (e.g., processing difficulties caused by conventional mirror surfaces) which the claimed invention was intended to address.

The Examiner attempts to rely on page 6, lines 10-16 in Steigerwald to support his allegations. However, this passage merely refers to an "optional barrier layer" which is used to "promote adhesion".

However, this is completely unrelated to the mirror surface of the claimed invention. Indeed, Steigerwald explains that the "barrier layer is chosen to optimize adhesion" (Steigerwald at page 6, line 14).

However, nowhere do these passages disclose the novel features of the claimed invention. Specifically, Applicant submits that the "barrier layer" of Steigerwald cannot be equated with the "light transmission layer" of the claimed invention. Indeed, Steigerwald even explains that the "barrier layer" can be spot-formed to provide "partial coverage" and "provide the maximum reflectivity with adequate adhesion" (Steigerwald at page 6, lines 17-24; Figures 6A-6B). Therefore, the "barrier layer" in Steigerwald is not a "layer" at all, but merely globs of "glue" used for adhesion.

Likewise, Steigerwald does not disclose or suggest a "corrosion-resisting layer" which may be formed on the reflection layer as recited, for example, in claim 2. Indeed, the Examiner even concedes that Steigerwald does not disclose or suggest this feature of the claimed invention.

Therefore, it is clear that Steigerwald does not teach or suggest the novel features of the claimed invention. Thus, the Steigerwald device would likely experience the same problems encountered with conventional devices (e.g., after the mirror surface is formed, it would be impossible to form a scribe line in the reverse side of the substrate, and the reflection layer would deteriorate quickly causing a reduction in reflectivity of the mirror surface) as described in the Background section of the Application.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. The Lester Reference

The Examiner alleges that Lester would have been combined with either Morita or a combination of Morita and Steigerwald to form the claimed invention (e.g., as claimed in claims 2, 3, 5, 7, 9, 11, 13, 16, 18, 20-23, 25, 27, 29 and 31). Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Lester discloses an LED which includes a dielectric encapsulant deposited over the p-type contact to allegedly improve the contact's adhesion by tacking it down at regular intervals, and to allegedly improve light extraction (Lester at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems. Specifically, Lester is intended to improve adhesion of a contact metal, which is related to Morita and Steigerwald. Clearly, no person of ordinary skill in the art would have considered combining these references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner merely states that it would have been obvious to combine these references "for either the purposes of preventing the Morita reflector from becoming scratched or oxidized as taught by Lester" which is insufficient to support the combination.

Moreover, Lester, like Morita and Steigerwald, does not teach or suggest a light-emitting semiconductor device having a mirror surface which includes "*a light transmission layer which directly contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics; and a*

reflection layer which is formed on said light transmission layer, comprises a metal, and reflects lights emitted from said emission layer" as recited in claim 1, or "*a reflection layer which comprises a metal and reflects lights emitted from said emission layer; and a corrosion-resisting layer which is formed on said reflection layer and comprises at least one of a metal oxide and a ceramic*" as recited in claim 2. These novel features (e.g., a novel mirror surface) help to provide a light-emitting device which has a larger luminous output an a longer performance life, and can be mass-produced at a low cost (Application at page 12, line 14-page 13, line 10).

Clearly, Lester does not teach or suggest these novel features. Indeed, like Morita and Steigerwald, Lester does not even recognize at least one of the problems (e.g., processing difficulties caused by conventional mirror surfaces) which the claimed invention was intended to address.

The Examiner attempts to equate the encapsulant 22 in Lester with the "corrosion-resisting layer" of the claimed invention. However, this is clearly erroneous.

Specifically, the encapsulant 22 in Lester is merely formed on the contact pads 20 (Lester at Figure 4). Nowhere does Lester disclose a mirror surface which includes a corrosion-resisting layer formed on a reflective layer. Indeed, the purpose of the encapsulant is to "[allow] light to be internally-reflected above rather than below the silver mirror" which unrelated to the corrosion-resisting layer of the claimed invention (Lester at col. 4, lines 65-66).

Likewise, Lester, like Morita and Steigerwald, does not disclose a "light transmitting layer" which may be formed on the substrate surface as recited, for example, in claim 1.

Therefore, like Morita and Steigerwald, the Lester device would likely experience the same problems encountered with conventional devices (e.g., after the mirror surface is formed, it would be impossible to form a scribe line in the reverse side of the substrate, and the reflection layer would deteriorate quickly causing a reduction in reflectivity of the mirror surface) as described in the Background section of the Application.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-31, all the claims presently being examined in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 1/30/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend the claims to read as follows:

1. (Amended) A light-emitting semiconductor device comprising:

a substrate;

a plurality of [plural] semiconductor layers which comprise group III nitride group compound semiconductors and are laminated on said substrate by crystal growth;

an emission layer formed on a first side of the substrate; and

a mirror surface formed on a second side of the substrate opposite the first side, said mirror surface comprising: [, wherein the mirror surface is formed by laminating]

a light transmission layer which directly contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides [oxide] and ceramics; [, both having luminous transparency,] and

a reflection layer which is formed on said light transmission layer, comprises a metal, [metals] and reflects lights emitted from said emission layer [, on the reverse side of said substrate to the side on which said emission layer is formed].

2. (Amended) A light-emitting semiconductor device comprising:

a substrate;

a plurality of [plural] semiconductor layers which comprise group III nitride group compound semiconductors and are laminated on said substrate by crystal growth;

an emission layer; and

a mirror surface comprising: [wherein said mirror surface is formed by laminating]

a reflection layer which comprises a metal [metals] and reflects lights emitted from said emission layer; and

a corrosion-resisting layer which is formed on said reflection layer and comprises at least one of a metal oxide and a ceramic [ceramics].

5. (Amended) A light-emitting device using group III nitride group compound

semiconductor according to claim 2, further comprising:

a light transmission layer which directly contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics,

wherein said reflection layer is formed by using at least one of aluminum (Al), Silver (Ag), and an alloy including at least one of these materials.

7. (Amended) A light-emitting device using group III nitride group compound semiconductor according to claim 2, further comprising:

a light transmission layer which contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics,

wherein a thickness of said reflection layer is in a range of 5 nm to 20 μm.

9. (Amended) A light-emitting device using group III nitride group compound semiconductor according to claim 2, further comprising:

a light transmission layer which contacts said substrate, has luminous transparency, and comprises at least one material selected from a group consisting of metal oxides and ceramics,

wherein said light transmission layer comprises [is formed by using] at least one of [metal oxides and oxides having luminous transparency such as] Al_2O_3, TiO_2, MgO, $MgCO_3$, Ta_2O_5, ZnO, In_2O_3, SiO_2, SnO_2, and ZrO_2.

11. (Amended) A light-emitting device using group III nitride group compound semiconductor according to claim 5, wherein said light transmission layer comprises [is formed by using] at least one of [metal oxides and oxides having luminous transparency such as] Al_2O_3, TiO_2, MgO, $MgCO_3$, Ta_2O_5, ZnO, In_2O_3, SiO_2, SnO_2, and ZrO_2.

13. (Amended) A light-emitting device using group III nitride group compound

semiconductor according to claim 7, wherein said light transmission layer comprises [is formed by using] at least one of [metal oxides and oxides having luminous transparency such as] Al_2O_3, TiO_2, MgO, $MgCO_3$, Ta_2O_5, ZnO, In_2O_3, SiO_2, SnO_2, and ZrO_2.